14–19. The St. Peter appears to have been derived from a relatively low land mass to the northward. This land is believed to have sloped southward, in which direction its rivers flowed, to have been affected by a moderately humid climate, but not to have been clothed with vegetation, because land plants had not yet developed. The land included pre-Cambrian crystalline rocks and a broad fringe of Potsdam sandstone.

20. The derivation of the St. Peter, largely from this Potsdam belt in which the sands were already well assorted and rounded, together with the added sorting and rounding by wind work in the supply area, and by waves in the sea, explains in a wholly satisfactory manner the high degree of purity and rounding of its grains.

21. These sands were delivered to the sea both by rivers and to a minor degree directly by winds, and were distributed chiefly by waves and currents.

22. The shores of this sea were fluctuating, but during middle and late St. Peter time, were for the most part north of the Iowa-Minnesota line.

23. North of that line there is quite probably a small amount of St. Peter that is truly unmodified terrestrial deposit. . . .

24. South of the Iowa-Minnesota line, conditions of both transportation and deposition were almost wholly marine, and in this area there did not exist during any part of St. Peter time, a great interior desert of drifting sand.

A discussion of the geographic conditions under which this and other early Proterozoic formations were made, closes the volume.

R. D. S.

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*Deposits of Manganese Ore in Arizona.* By E. L. JONES, JR., and F. L. RANSOME. Bulletin 710-D, United States Geological Survey, Government Printing Office, Washington, D.C., 1920. Pp. 92, pls. 6, figs. 8.

The production of manganese ore as such in Arizona dates from 1915. The producing district lies in the more southern part of the state. The greater part of the ore worked bears at least 35 per cent manganese, and not more than 4 per cent iron. The ore is shipped east to Illinois, Alabama, Tennessee, and Pennsylvania, and lately also to California. Perhaps the chief difficulty encountered in production lies in the inaccessibility of the mines to railroads, which necessitates "packing" the manganese out of the mining district, a tedious and expensive process.

Various scattered manganese have been studied by Mr. Jones in the preparation of this paper. Dr. Ransome describes those at Bisbee and Tombstone. In the latter district, the sequence extends from the pre-Cambrian Pinal schist through Cambrian, Devonian, Mississippian,

Pennsylvanian, Triassic (or Jurassic), and Comanchean rocks. These are mostly limestones, though the early Mesozoic is marked by porphyritic intrusions and the lower part of the Cambrian series is quartzitic. The manganese ore, largely psilomelane, occurs in irregular bodies in close association with fissures in the Carboniferous limestones; the deposits follow the fissures, or extend laterally from them along certain beds of limestone; they seldom descend to depths greater than fifty feet and are worked by open cuts or shallow inclines. With the hard psilomelane are lesser amounts of barite, quartz, a green copper-arsenic compound (new species), and soft black pyrolusite; chalcolite is occasional.

In the Tombstone district the manganese grades into ores rich in the precious metals; it occurs in irregular pipelike masses or chimneys distributed along fault zones.

Almost certainly these manganese deposits are related to the copper ores, as they are generally closely associated. The manganese ores are unquestionably supergene, being generally found only in the oxidized zone. Psilomelane deposition seems to have been conditioned chiefly by fissuring. In the Tombstone district, manganese-silver ores are as common as manganese-copper ores in the Bisbee region, and possibly the manganese zone here represents a leached silver zone. The deposits, on account of their irregularity, can only be worked under unusual conditions. Possibly not more than 60,000 tons of 40 per cent ore are available in these two districts combined.

Elsewhere in the state, in Coconino, Graham, Greenlee, Maricopa, Mohave, Pinal, Santa Cruz, Yavapai, and Yuma counties, there are smaller manganese deposits. Here veins, brecciated zones, bedded deposits, and irregular deposits with travertine, all furnish greater or lesser amounts of manganese ores. The ores are in pre-Cambrian granites and gneisses, Tertiary rhyolites, andesites, and dacites, and Quaternary basalts, as well as in limestones and quartzites of Paleozoic age, sandstones of Tertiary age and course clastics of the Quaternary. The manganiferous silver veins occupy an important place among the vein deposits; they are well shown in the Hartshell shear zone ores and in the Globe district; in such cases the manganese oxides are psilomelane, pyrolusite, braunite, manganite, and wad. There may be more or less iron oxide associated, as in the Globe district, where the ores are intimate mixtures of manganese- and iron-oxides. Where braunite is the chief ore mineral, it is commonly associated with cerusite, vanadinite, and wulfenite.

Veins barren of silver are widely scattered throughout the southern part of the state and include most of the deposits examined. They are most common in Tertiary lavas. The ore-shoots vary greatly in size. The ore consists of oxides derived from the weathering of vein material, hence its depth depends largely on the permeability of the rock to circulating water. The ore minerals are psilomelane, pyrolusite, and manganite; these are accompanied by barite, calcite, and iron oxide.

Bedded deposits vary as to character and associated rocks. They may be contained in tuffs, or they may be the result of replacement of sandstone. They are generally of Tertiary age. Such deposits do not extend to great depths and are worked through shallow pits and shafts. The manganese minerals are psilomelane, pyrolusite, manganite, and subordinately braunite. Quartz, feldspar, iron ores, and calcite are the chief gangue minerals—partly secondary, partly the unreplaced minerals of the rock. Much of this ore, developed in sandstones and only partially replacing the country rock, is siliceous.

Manganese ore associated with travertine is known from one locality only; here the travertine and the clayey manganese-bearing beds are capped by basalt. The manganese mineral is principally botryoidal and vesicular psilomelane.

A detailed description of the geography, geology, and manganese deposits of each of the districts is given; for these the reader is referred directly to the carefully prepared paper itself.

C. H. B., Jr.

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*World Atlas of Commercial Geology; Part I, Distribution of Mineral Production.* United States Geological Survey, 1921. Pp. 72, pls. 72.

The purpose of this atlas, prepared by more than a score of geologists, is "to set forth graphically and to describe concisely the basic facts concerning both the present and the future sources of the useful minerals." Part I deals chiefly with present sources; later parts will exhibit, so far as practicable, the mineral reserves of the world. The maps of Part I, which deal with the most important thirty mineral commodities, are arranged in groups of eight, each group containing (1) a map of the world showing production and, for major commodities, consumption by countries in 1913, the last year of normal production; (2) a map of each of the continents, indicating production by countries, districts, or fields, in percentages of the world's production in 1913; and (3) a map of the United States, exhibiting production in 1918 by states, districts, or fields, in percentages of the total output of the country.